

International Comparison on Modal Share of Intercity Passenger Trips in Asian Countries

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The objective of the study is to understand mechanism of intercity travel behavior by comparing modal shares internationally based on aggregated OD data collected from 8 Asian countries. Under a hypothesis that modal share changed by development stage of transport system, competitive distance range of each mode was estimated, and transport system of each country was classified into three development stages: 1) the initial stage, 2) the stage affected by advanced motorization, and 3) the stage after introduction of high speed railway. Moreover, focusing on the system of high speed railway, Japan, Korea and Taiwan were compared with respect to modal share, level of service, and mode selection model constructed by multi nominal logit model to observe their differences in role and service.

Key Words : intercity passenger trips, modal share, international comparison, Asian countries, logit model

1. INTRODUCTION

(1) Background

In recent years, many countries in Asia have experienced rapid and continuous economic growth, and as economy grows and motorization advances, traffic demand has drastically increased. However, transport structure is insufficient for the increasing traffic demand and needs. As seen in the current Asian mega cities such as Manila, Bangkok and Jakarta, traffic congestions are causing and enlarging economic losses, which is an acknowledged serious social problem.

Not only economic losses, but also natural and social environmental losses are concerned. Low service level and reliability of bus and rail lower modal share of public transport and increase the share of private car. The high share of car increases air pollution and traffic accidents. Moreover, lack of infrastructure for intercity transport increases regional disparity between a metropolitan area and provincial cities.

The issues mentioned above are originated or

amplified by very high speed of growth that the present developed countries in the West have never experienced in their histories. Therefore, the unique characteristics of Asian countries should be taken into account in the policy study, which are the dynamics of rapid change in economic growth, urbanization, high population density and city structure with monopolar concentration, etc.

(2) Objectives

The countermeasure policies against those issues mentioned above should be something to induce “desirable behavior” for sustainable development, and then it is necessary to understand what the “desirable behavior” is and what the mechanism of travel behaviors is. Therefore, this study focuses on the current situation and mechanism of travel behaviors in intercity passenger trips in Asian countries. Intercity transport in Asian countries has been covered less by the previous studies as compared to urban transport, so intercity passenger trips are selected as subject for this paper.

The objectives of the study are to observe the

present modal shares of targeted 8 countries, to set up a hypothesis and verify that modal share changes by development stage of transport system, and to compare the high speed railway (HSR) system of Japan, Korea, and Taiwan with respect to modal share, level of service, and mode selection model.

2. REVIEW OF THE PREVIOUS STUDIES

This study is mainly referring to the previous studies on intercity passenger trips in Asian countries by S. Morichi and S. R. Acharya. They hypothesize that the fundamental problem inducing inefficient modal share is dominant and disproportional share of private car and airplane, and the desirable intercity passenger trip behavior is balanced multimodal share. It is empirically proved that a balanced share of rail, bus, car and airplane leads efficient and sustainable intercity transport system. Especially, rail is a superior mode from environmental, social and economic point of views, so rail should be prioritized for high-demanded trunk route.

Premising hypothesis of the previous study, this study focuses on modal share of private car and airplane and system of HSR.

3. COLLECTED OD DATA

Data used for analysis are listed in the Table 1 and collected from eight Asian countries, which source is different for each country. The OD pairs are intercity passenger trips between the capital or the largest city in the country and regional cities. The data contains travel distances, volume of daily passenger trips, travel time and cost for each mode, and some of them are subdivided by grade of mode in developing countries. Data of Japan is selected from the result of Inter-Regional Travel Survey (2005) conducted by the Ministry of Land, Infrastructure and Transport.

It should be noted here that the number of OD pairs are insufficient to calibrate a model with many attributes, so the analysis is under the constraints of available data.

4. COMPARISON OF MODAL SHARE

(1) Modal share of each country

Based on the collected OD data, modal share for each mode was calculated and plotted by travel distance for each country. Logistic curve was estimated as an approximate curve for each mode.

The case of Japan is shown in the Fig.1. Although

Table 1 Collected OD Data

Country	Origin	No. of OD pairs	GDP/capita (US\$)
Japan	Tokyo	19	39,740
Korea	Seoul	11	17,074
Taiwan	Taipei	36	16,372
Malaysia	Kuala Lumpur	8	6,950
Thailand	Bangkok	8	3,941
Indonesia	Jakarta	10	2,329
Viet Nam	Ho Chi Min	12	1,068
Nepal	Katmandu	11	462

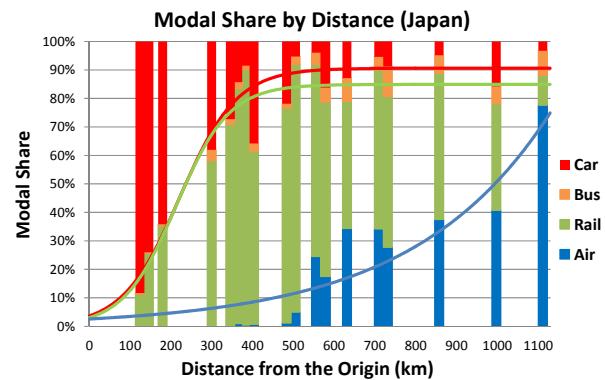


Fig.1 Modal share by travel distance, Japan

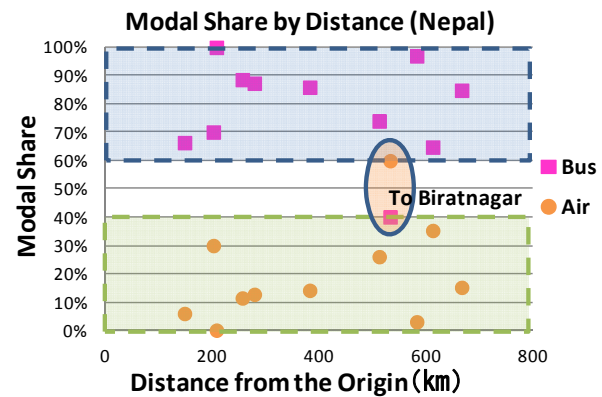


Fig.2 Modal share by travel distance, Nepal

modal shares were calculated and logistic curves were estimated for every targeted country, logistic curves were not able to approximate modal shares for the cases of Thailand and Nepal.

In Thailand, the major regional cities were spread in a radial pattern, while in other countries most regional cities collected for OD data were located along the country's trunk route. Thus, the modal share in Thailand did not have correlation to travel distances.

In Nepal, as shown in the Fig.2, the bus shares were more than 60% at any travel distances except for the OD to Biratnagar, and no relation was found to the travel distances. The results showed that airplane was not affordable for the most people in

Nepal. Biratnagar is the second largest city next to Katmandu, and the income level is higher than the other destination cities. Therefore, the airplane share became higher than the bus share exceptionally for the OD pair.

(2) Working hypothesis

Working hypothesis of this study is that modal share in Asia countries changes by development stage of transport system and is correlative to GDP of the country. To observe the changes, development stages are classified into the following three stages; 1) the initial stage is the stage that because car ownership ratio is low, modal share of public transport such as bus and rail is very high for short distance travels. Also, air transport becomes competitive at very long travel distance range because airplane is not affordable for most people in the country. 2) The second stage is the stage affected by advanced motorization. The income level and traffic demand increases as economy grows, and car ownership ratio increases as well. The more motorization advances, the more modal share of car and airplane increases because the service level and reliability of bus and rail do not meet their demand and needs. Thus, competitive distance range of car becomes longer, and airplane demand increases for shorter distances than in the first stage, and 3) the third stage is the stage after introduction of HSR. The service level of rail drastically increases with introduction of HSR. Rail becomes the most superior mode in the middle to long travel distances. Then, car becomes competitive only for short distances, and airplane is selected only for longer travel distances again.

Then, to verify the hypothesis, modal share of the targeted countries were compared by their competitive travel distance range of each mode for each stage.

(3) Comparison of competitive distance range

As claimed in the previous studies that the fundamental problem inducing inefficient modal share is dominant and disproportional share of private car and airplane. Then, this study defined that travel distance for a mode to be the most competitive was the distance with more than 50% share, so the travel distance of 50% share was estimated by logistic curves for each country and mode in the study.

Considering countries' GDPs, Viet Nam was selected as a representative country for the first stage in the working hypothesis, Malaysia was for the second stage, and Japan was selected for the third stage.

The Fig.3 shows modal share of car by travel distance. The number labeled in the figure is a development stage pointing at 50% share of each representative country. The figure showed that 50% share distances of car in Japan and Taiwan were shorter

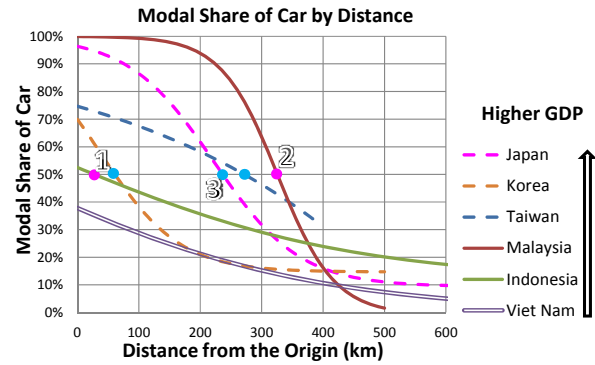


Fig.3 Modal share of car by distance

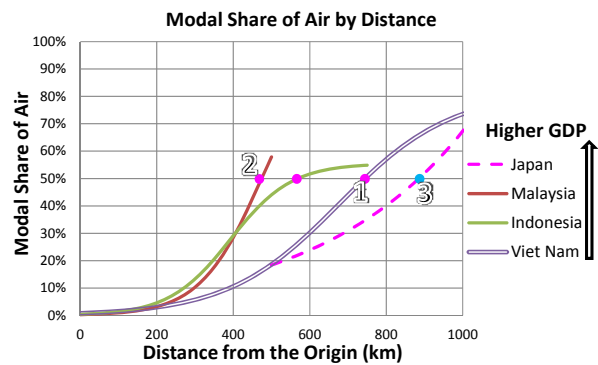


Fig.4 Modal share of air transport by distance

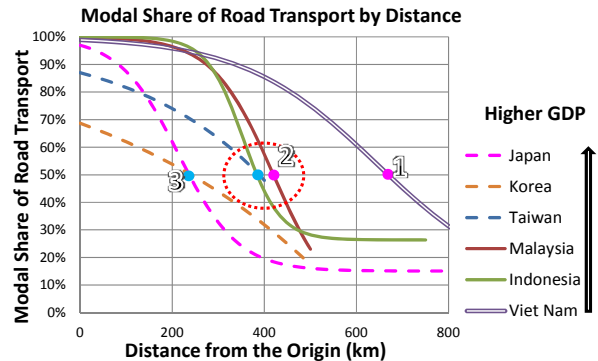


Fig.5 Modal share of road transport by distance

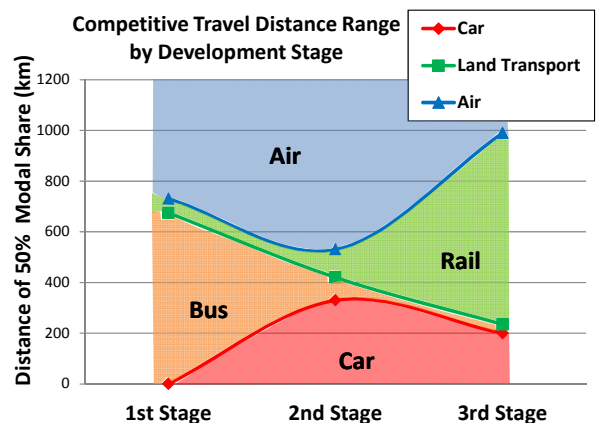


Fig.6 Conceptual diagram for competitive travel distance by development stage

than Malaysia because HSR was available in those countries. The figure also showed that the ownership ratio of car in Viet Nam was too low to reach 50% car share at any distances, and the shares of Malaysia and Indonesia showed that the higher GDP the country had, the longer 50% share distance was.

The Fig.4 shows modal share of airplane by travel distance. The 50% share distance of airplane was about 750km in Viet Nam, but as GDP/capita increased, people began to choose airplane for relatively shorter travel distances, so the 50% share distance decreased as in Malaysia with higher GDP/capita. On the other hand, people choose HSR over airplane for mid-long travel distances in Japan, as the result, 50% share of airplane in Japan became long back as 990km.

The Fig.5 shows modal share of road transport including car and bus. The 50% share distance of road transport was approximately the same as 400km in Taiwan, Malaysia and Indonesia. The result indicated that demand of road transport in Taiwan was not shifted to HSR as Japan or Korea did, even after HSR started the service.

Based on the cases of representative countries, which are Viet Nam for the first stage, Malaysia for the second stage and Japan for the third stage, the 50% share distances of car, airplane and road transport are plotted by development stage in the Fig.6.

The areas shown in red and blue indicate travel distance ranges that shares of car and airplane exceed 50% respectively. The areas in orange and green indicate the competitive travel distance ranges of bus and rail, but they are not necessary for bus and rail share to exceed 50% in share.

As seen in this figure, the competitive travel distance range of each mode changes by development stage of transport system as illustrated in the working hypothesis. This figure can be seen as a conceptual diagram to support the hypothesis of this study.

5. COMPARISON BETWEEN THREE COUNTRIES WITH HSR

To observe difference in role and service of HSR, Japan, Korea and Taiwan were compared with respect to modal share, level of service of HSR, and mode selection model.

(1) Modal Share

The Fig.7-9 shows modal share of Japan, Korea and Taiwan respectively.

The HSR share of Japan and the main corridor, Geongbu-line in Korea showed almost the same trend, while Taiwan's HSR share did not reach the

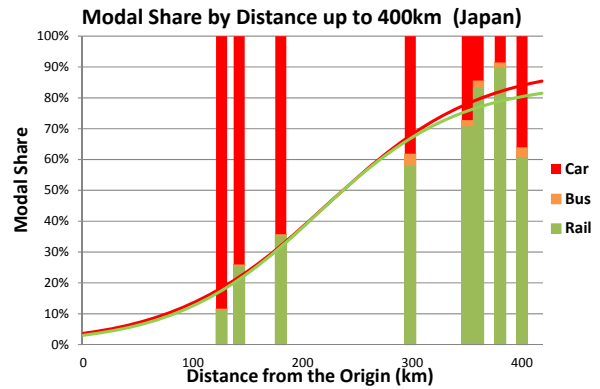


Fig.7 Modal share of Japan within 400km travel distance

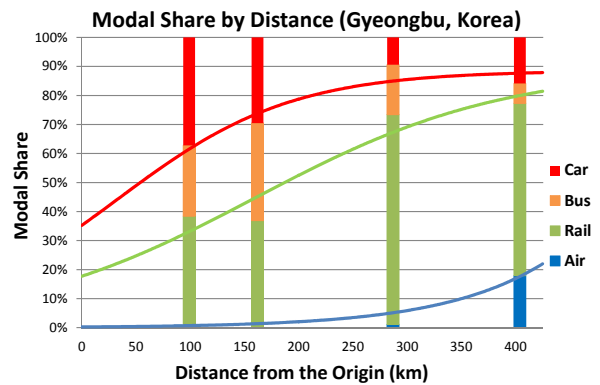


Fig.8 Modal share of Gyeongbu-line, Korea

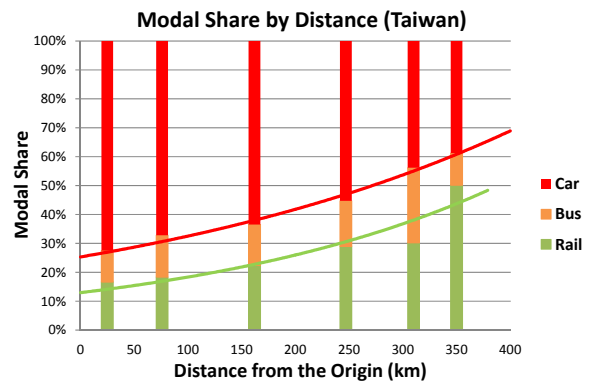


Fig.9 Modal share of Taiwan

same level as of Japan and Korea. The HSR of Taiwan was introduced with BOT method, and to secure lands for private sector to develop, HSR stations were located far from the city center. From HSR stations, people had to take shuttle bus to go to the city center for 30 to 40 min., which resulted in lower Taiwan's HSR share than of the other two.

The bus share of Korea and Taiwan occupied substantial percentage compared with the case of Japan. Especially in Taiwan, bus shares kept more than 10% at any travel distances. Deregulation was enforced for intercity bus in 1996, which seemed to be affecting the bus share of Taiwan.

(2) Level of service

Travel time of HSR was the same level among

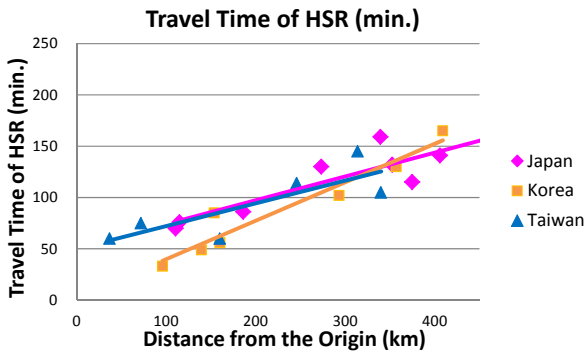


Fig.10 Travel time of HSR

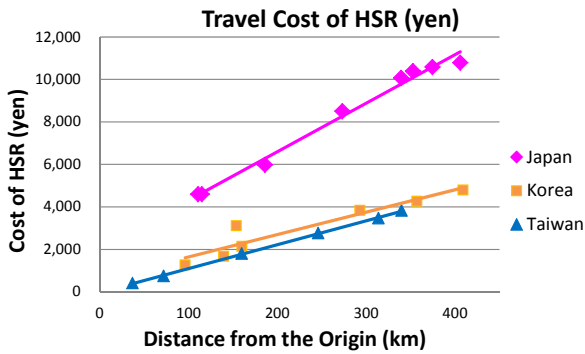


Fig.11 Travel cost of HSR

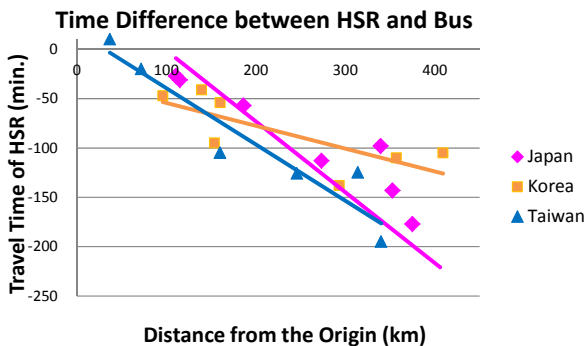


Fig.12 Time difference between HSR and bus

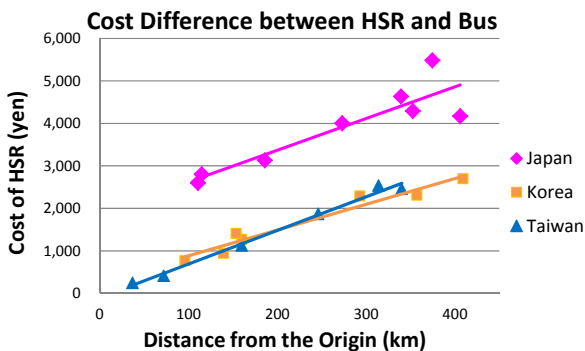


Fig.13 Cost difference between HSR and bus

three countries as shown in the Fig.10, however, the speed of Korea was slightly higher at short distances. Then, travel costs set for HSR in Korea and Taiwan were at the same level as shown in the Fig.13, however costs in Japan were significantly higher than the other two.

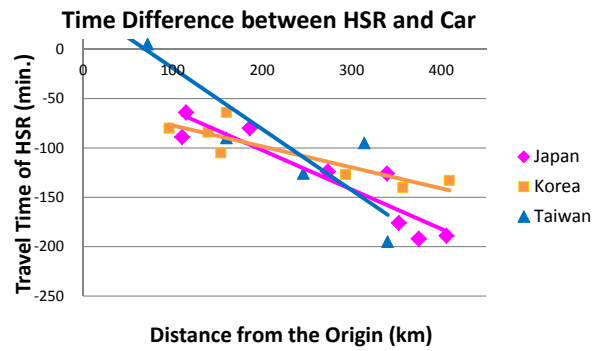


Fig.14 Time difference between HSR and car

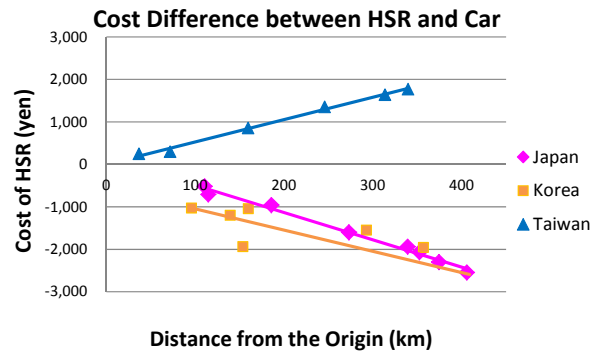


Fig.15 Cost difference between HSR and car

The Fig.12 and 13 shows differences in time and cost between HSR and Bus. The time differences with bus of Korea were slightly less than of Japan and Taiwan. In Korea, high occupancy vehicle lane is introduced at the congested section, which is considered to be a reason for bus to obtain higher speed.

The Fig.14 and 15 shows differences in time and cost between HSR and private car. Travel time difference from car was the same level among three countries. On the other hand, cost differences in Taiwan showed opposite signs to the ones in Japan and Korea, which indicated that travel costs of car were less than HSR and leading high shares of car in Taiwan.

(3) Mode selection model

1) Conditions of the model

Using the collected aggregated data, mode selection models were constructed by multi nominal logit model for Japan, Korea and Taiwan, and value of times were calculated based on parameters of the constructed models and compared. Considering the fact that it was difficult to collect detailed data from countries other than Japan, variables generally included in mode selection model with disaggregated data such as access and egress conditions or income level were not counted in this model (see (1a) and (1b)). The purpose of this model analysis was to observe differences in travel behavior of countries, not to estimate the future traffic demand. Therefore, estimated model was set to be simple with only a few

Table 2 Estimated parameters of logit model

Country (# of OD)	β_1 (hour)	β_2 (1,000JPY)	Likelihood Ratio, ρ^2
Japan (19)	-0.368	-0.117	0.19
Korea (7)	-0.932	-0.242	0.27
Taiwan (6)	-0.589	-0.383	0.15

parameters of travel time, cost and constant as shown below.

$$V_m = \beta_1 \cdot (Time) + \beta_2 \cdot (Cost) + \alpha \quad (1a)$$

$$P_m = \frac{\exp(V_m)}{\sum_M \exp(V_i)} \quad (1b)$$

Conditions set for model were; the origin was country's capital for all OD pairs, zones were limited to the zones having a HSR station, data were for all purposes, weekday and daily passenger, unit of variables were hours and 1,000 JPY and mode choices were airplane, rail, bus and car.

2) Calculation result

The calculation results for parameters are shown in Table 2. Since the number of OD pairs was too few to calibrate such sensitive models, it was not appropriate to state any observations at this point. Therefore, the following observations are only possibilities;

By looking at cost parameter, the higher GDP/capita the country had, the lower cost parameter was, so the cost parameters could have correlation to country's GDP/capita. Moreover, the value of time (VOT) was 3,154 JPY/hour for Japan, 3,844 JPY/hour for Korea and 1,538 JPY/hour for Korea. The VOTs of Japan and Korea were significantly higher as compared with of Taiwan. The VOTs could be reflecting the share of HSR (see Fig.7, 8 and 9).

6. CONCLUSION

At first, hypothesizing that modal share changed by development stage of transport system, competitive distance range of each mode were estimated and classified into three development stages: 1) the initial stage, 2) the stage affected by advanced motorization, and 3) the stage after introduction of HSR.

Assuming that turning point for a mode to become competitive in travel distance was the distance where modal share became 50%, the 50% share distance was compared for each mode and country. The 50% share distance of car became longer as country's GDP and car ownership ratio increased. However, the trend reversed after introduction of HSR. The 50% share distance of airplane decreased as GDP increased because the higher income was, the more affordable airplane became, but the trend reversed after introduction of HSR. From the observations above, the study results supported the working hypothesis.

Secondly, using the collected aggregated data, mode selection models were constructed for Japan, Korea and Taiwan, and value of times were calculated. The results found possibilities that cost parameters had correlation to country's GDP/capita, and VOTs was reflecting the share of HSR. However, available OD pairs in the calculations were too few to make any conclusions, so the next step of this study will be to construct models using disaggregated data of Japan and compare with the models with aggregated data to check their reliability.

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